

What is claimed is:

1. A method of adjusting the volume of data communicated between a transmitter and a receiver on a network in a time interval, the method comprising:
- 5 a) producing a desired volume value in response to a receiver volume value specified by the receiver and a difference between a target departure volume and an estimate of arrival volume of data at a queue through which data passes from the transmitter to the receiver; and
- b) communicating said desired volume value to the transmitter in response to an acknowledgement signal produced by the receiver.
- 15 2. The method claimed in claim 1 further comprising detecting an acknowledgement signal produced by the receiver in response to receipt of a data packet at the receiver.
3. The method claimed in claim 2 wherein communicating said desired volume value to the transmitter comprises:
- 20 a) generating a network element volume value; and
- b) communicating at least one of said receiver volume value and said network element volume value to the transmitter.
4. The method claimed in claim 3 further comprising extracting said receiver volume value from said acknowledgement signal.
5. The method claimed in claim 4 wherein producing said desired volume value further comprises extracting a plurality of receiver volume values from a plurality of acknowledgement signals.

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6. The method claimed in claim 5 wherein producing said desired volume value comprises setting as said receiver volume value a maximum receiver volume value of said plurality of receiver volume values.
 7. The method claimed in claim 4 wherein communicating said desired volume value to the transmitter comprises communicating the lesser of said receiver volume value and said network element volume value to the transmitter.
 8. The method claimed in claim 7 wherein communicating further comprises producing a modified acknowledgement packet including said lesser of said receiver volume value and said network element volume value and communicating said modified acknowledgement packet to said transmitter.
 9. The method claimed in claim 3 wherein generating said network element volume comprises time filtering successive arrival volume values to produce a filtered arrival volume value.
 10. The method claimed in claim 9 wherein time filtering comprises producing a weighted sum of present and past arrival volume values.
 11. The method claimed in claim 10 wherein generating said network element volume value comprises generating an estimated target data packet departure volume in response to a service volume of the queue and a target utilization factor of the queue.
 12. The method claimed in claim 11 wherein generating said network element volume value comprises controlling a size of the queue.
 13. The method claimed in claim 12 wherein controlling the size of the queue comprises producing a scaling factor in response to whether queue occupancy is greater than a threshold value.

- 5 14. The method claimed in claim 13 wherein generating said network element volume value comprises generating said network element volume value as a function of a previous network element volume value, a control gain, said scaling factor, a target departure volume of data leaving the queue and said filtered arrival volume value.
- 15 15. The method claimed in claim 3 wherein generating said network element volume value comprises bounding said network element volume value between a maximum value and a minimum value.
- 15 16. A computer readable medium for providing codes for directing a processor to:
- 20 a) produce a desired volume value at which packets are communicated between a transmitter and a receiver on a network, in response to a receiver volume value specified by the receiver and a difference between a target departure volume and an estimate of arrival volume of data at a queue through which data passes from the transmitter to the receiver; and
- 25 b) communicate said desired volume value to the transmitter in response to an acknowledgement signal produced by the receiver.
- 20 17. A signal embodied in a carrier wave, said signal having code segments for directing a processor to adjust a volume at which packets are communicated between a transmitter and a receiver on a network, the signal comprising:
- 25 a) a first code segment for directing said processor to produce a desired volume value in response to a receiver volume value specified by the receiver and a difference between a target departure volume and an estimate of arrival volume of data at a queue through which data passes from the transmitter to the receiver; and

- b) a second code segment for directing said processor to communicate said desired volume value to the transmitter in response to an acknowledgement signal produced by the receiver.

5 18. An apparatus for adjusting the volume of data communicated between
a transmitter and a receiver on a network in a time interval, the
apparatus comprising:

- a) means for producing a desired volume value in response to a receiver volume specified by the receiver and a difference between a target departure volume and an estimate of arrival volume of data at a queue through which data passes from the transmitter to the receiver; and
 - b) means for communicating said desired volume value to the transmitter in response to an acknowledgement signal produced by the receiver.

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19. An apparatus for adjusting the volume of data communicated between a transmitter and a receiver through a queue on a network in a time interval, the apparatus comprising:

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- a) a detector for detecting an acknowledgement signal produced by the receiver in response to receipt of a data packet at the receiver;
 - b) a volume value generator for computing a network element volume value in response to a receiver volume value specified by said acknowledgement signal and a difference between a target departure volume and an estimate of arrival volume of data at a queue through which data passes from the transmitter to the receiver ; and

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- c) a signal modifier for producing a modified acknowledgement signal including a desired volume value for communication to the transmitter, in response to said network element volume value and a receiver volume value identified in said acknowledgement signal.

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- 20. The apparatus claimed in claim 19 wherein said detector is operable to receive a data packet from the receiver.
 - 21. The apparatus claimed in claim 20 wherein said signal modifier communicates to the transmitter at least one of said receiver volume value and said network element volume value as said desired volume value.
 - 22. The apparatus claimed in claim 21 wherein said signal modifier extracts said receiver volume value from said acknowledgement signal.
 - 23. The apparatus claimed in claim 22 wherein said signal modifier extracts a plurality of receiver volume values from a plurality of acknowledgement signals and selects as said receiver volume value a maximum receiver volume value of said plurality of receiver volume values.
 - 24. The apparatus claimed in claim 23 wherein said signal modifier communicates to the transmitter the lesser of said receiver volume value and said network element volume value, as said desired volume value.
 - 25. The apparatus claimed in claim 19 wherein said volume value generator comprises a filter for time filtering successive data arrival volume values to produce a filtered data arrival volume value.
 - 26. The apparatus claimed in claim 25 wherein said filter is operable to produce a weighted sum of present and past arrival volume values.

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27. The apparatus claimed in claim 19 wherein said volume value generator comprises a departure volume value generator for generating an estimated target data packet departure volume value in response to an actual service volume value of the queue and a target utilization factor of the queue.

28. The apparatus claimed in claim 19 wherein said volume value generator further comprises a queue size control mechanism for controlling the size of the queue.

29. The apparatus claimed in claim 28 wherein said queue size control mechanism comprises a processor circuit for computing a scaling factor to diminish said network element volume value when the number of packets in the queue exceeds a threshold value.

30. The apparatus claimed in claim 19 wherein said volume value generator generates said network element volume as a function of a previous network element volume value, a control gain, a scaling factor, a departure volume of data leaving the queue and a filtered arrival volume value.

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previous network element volume value, a control gain, a scaling factor, a departure volume of data leaving the queue and a filtered arrival volume value.

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